

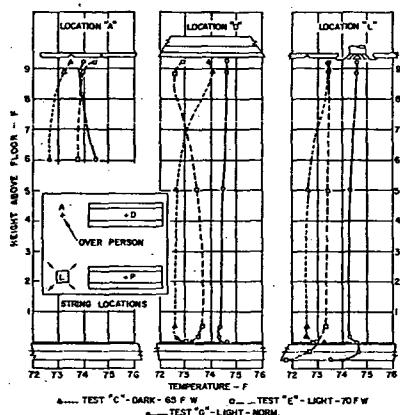


Fig. 10 . . . Room Temperature Patterns for Panel-Air System with Water-cooled Luminaires

uals to temperature deviations from the optimum was increased considerably over the observed tolerance for systems where all cooling was accomplished with the air supply. The increased tolerance is due partly to the uniform floor-to-ceiling temperature patterns developed with panel systems. Fig. 10 shows the results of placing strings of fine wire thermocouples in several locations in a water-cooled luminaire panel-air system.¹⁴

INSTALLATION COSTS

When compared with other types of systems which do not compromise interior conditions, panel-air systems will usually be somewhat higher in cost when considering only the mechanical contract. However, their use frequently will permit a reduction in ceiling space due to the decrease in required duct size, thus producing an overall saving when the structural and mechanical costs are considered on a combined basis. It is practicable, for example, to cool a 200 sq ft section of interior floor area of normal general office space using two water lines of $\frac{1}{2}$ in. copper tubing and two $\frac{1}{4}$ in. round ducts conveying air at conventional velocities.

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HEAT PUMP SYSTEMS FOR AIR CONDITIONING

Effect of Structure on System Design, Operating Cycles, Equipment Selection, Supplemental Heating, Heating Load Estimates, Compressors, Liquid Subcooling Coils, Defrosting and Draining of Coils, Factory Built Unitary Equipment, Controls, Heat Reclaiming Cycle, Operating Cost

THE six common heat pump circuits, with respect to the heat sources and heat sinks as well as the mediums used to supply the heating and cooling effect to the conditioned space, are discussed in Chapter 58 of the 1961 Guide And Data Book.

In addition to these basic circuits, there are many other instances, particularly in larger central plant type installations, where heating and cooling may be required simultaneously or where cooling and reheat is needed to maintain a specific relationship between temperature and relative humidity. Various possible heat pump arrangements to accomplish these and other such operating cycles, together with methods of improving the performance of the installation, are described and illustrated in this chapter.

EFFECT OF STRUCTURE ON SYSTEM DESIGN

The trend of modern buildings is to employ double glazed windows and better insulation, as well as to use more and more internal areas with considerably higher internal heat gain from lights, people, tabulating machines, and other similar heat dissipating equipment. Systems for such buildings are normally required, particularly during mild weather, to furnish heating to the exterior zones and cooling to the interior zones, simultaneously. In many instances these systems may have to change daily or even hourly, between the heating and cooling cycle, in order to maintain the required indoor conditions.

The heat pump is exceptionally qualified for such applications and frequently shows a considerable saving in operating cost over other systems, because of its inherent ability to transfer heat from an interior zone, for instance, where cooling may be desired to the exterior where heating may be needed.

OPERATING CYCLES

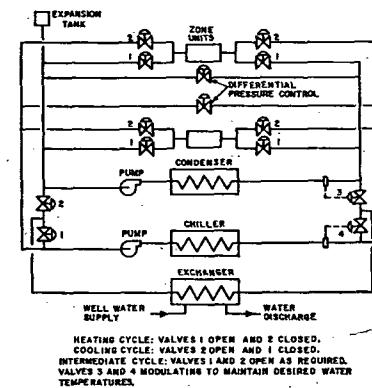
Figs. 1, 2 and 3 show three of the several possible operating cycles for simultaneously providing heating and cooling. Fig. 1 illustrates one method of using water as the heat source and sink and as the heating and cooling medium. Similarly, the cycle of Fig. 2 uses air as the heat source and heat sink, and a non-freeze liquid as the heating and cooling medium. In these two designs the compressor, condenser, chiller and all refrigerant piping and accessories can be preassembled at the factory and shipped as a compact unit with a hermetically sealed refrigerant circuit. The compressor, with a fixed refrigerant circuit between the condenser and chiller, is not shown. Also, the various automatic valves and controls needed for a particular installation, to obtain a desired performance, have not been included.

The cycle shown by Fig. 1 is very flexible and the heating or cooling medium is instantly available at all times. Heating may be exclusively provided to the zone conditioners by closing valves 2 and 3 and opening valves 1 and 4. With the valves in these positions, the water will be divided into two separate circuits. The warm water circuit consists of the con-

denser (where the heat is supplied by the high temperature refrigerant), valve 1, zone conditioners, and a circulating pump. The cold water circuit consists of the chiller (where heat is taken from the water by the low temperature refrigerant), valve 4, exchanger (where heat is taken from the well water), valve 1, and a circulating pump. The refrigerating compressor is operated to maintain the desired entering water temperature to the condenser.

Similarly, cooling may be exclusively obtained in the cycle of Fig. 1 by opening valves 2 and 3 and closing valves 1 and 4. With this arrangement, the cold water circuit will consist of the chiller (where heat is removed from the water by the low temperature refrigerant), valve 2, zone conditioners, and a circulating pump. The warm water circuit consists of the condenser (which receives the heat from the refrigerant), valve 3, exchanger (where heat is rejected to the well water), valve 2, and a circulating pump. The refrigerating compressor is operated to maintain the desired water temperature entering the chiller.

During the intermediate season, simultaneous heating and cooling may be provided by a cycle such as shown in Fig. 1, by modulating valves 3 and 4 when valves 1 and 2 are open. Valve 3 is usually adjusted to maintain 110-120 F water in the condenser circuit and valve 4 to maintain 45-50 F in the chiller circuit. The excess heating and cooling effect is wasted to the exchanger which in turn passes it on to the well water.



* To provide simultaneous heating and cooling with fixed refrigerant circuit. The well water can be supplied directly to the condenser and chiller instead of indirectly through the exchanger.

Fig. 1 . . . Water-to-Water Heat Pump Cycle*